

Hybrizon Fallén (Hymenoptera, Ichneumonidae, Hybrizontinae) in China

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Abstract

The species of the genus *Hybrizon* Fallén (Hymenoptera: Ichneumonidae: Hybrizontinae) from China are reviewed, with special reference to Shandong (North China). Two new species (*Hybrizon hei* **sp. nov.** and *H. xui* **sp. nov.**) are described and illustrated. A key to the East Palaearctic species of *Hybrizon* is included.

Keywords

Ichneumonidae; *Hybrizon*; Palaearctic; China; Shandong; endoparasitoids; ant larvae; key

Introduction

Hybrizon Fallén, 1813, belongs to the small subfamily Hybrizontinae Blanchard, 1845 (= Paxylommatainae Foerster, 1863, Hybrizoninae of some authors; Wharton and van Achterberg 2000) and contains endoparasitoids of ant larvae carried by workers outside their nest (Gómez Durán and van Achterberg 2011). Most likely the subfamily belongs to the family Ichneumonidae (Rasnitsyn 1980; Yu and Horstmann 1997), but was often associated with Braconidae (van Achterberg 1976) or considered to be a separate family (He 1981, Tobias 1988). The structure of the connection of

the second and third metasomal tergites and the venation of the hind wing, both indicate a closer relationship with the family Ichneumonidae (Sharkey and Wahl 1987; Wahl and Sharkey 1988) than with the Braconidae. According to the analysis of 28S ribosomal RNA Hybrizontinae are at a basal position of the Ichneumonidae-lineage (Belshaw et al. 1998; Quicke et al. 2000; Belshaw and Quicke 2002), but Gillespie et al. (2005) documented the unusual structure of 28S in *Hybrizon*, which makes proper alignment difficult. Quicke et al. (2009) and Broad et al. (2018) placed *Hybrizon* as derived subfamily within the ophioniformes-group of the Ichneumonidae. In the most recent overview (Bennett et al. 2019) Hybrizontinae are also included in the ophioniformes and grouped with part of the Ctenopelmatinae if all morphological and molecular data are combined. When only the molecular data are used Hybrizontinae cluster with Tersilochinae, Cremastinae, part of Mesochorinae and Sisyrus-tolinae. Hybrizontinae can be most easily separated by their aberrant venation of the fore wing (Figs 10, 17, 24), the antenna of both sexes with only 13 segments and the enlarged hind basitarsus. Only Neorhacodinae show a similar fusion of veins SR and M (= vein 3-SR+M) of the fore wing (as a result no vein r-m is present) and have also antenna with 13 segments, but Neorhacodinae lack the enlarged hind basitarsus of Hybrizontinae. Neorhacodinae are not considered to be closely related, but are grouped also in the ophioniformes (Bennett et al. 2019). *Hybrizon* is known from the Holarctic region and the NE part of the Oriental region (van Achterberg et al. 2013). Only three other extant genera are known, of which two are very similar: *Eurypterna* Foerster, 1863 (= *Ogkosoma* Haupt, 1913) and *Ghilaromma* Tobias, 1988 (Tobias 1988; van Achterberg 1999). The third extant genus is described very recently from Japan (*Neohybrizon* Hisasue & Konishi, 2019) with only the type species (*N. mutus* Hisasue & Konishi, 2019) known. *Neohybrizon* differs from the other extant genera by the extremely reduced mouth parts, the longer mesoscutum, the absence of the prepectal carina, the depressed medio-posterior area of the mesoscutum, the larger parastigma, the slenderer pterostigma, the straight vein 1-SR+1-M of the fore wing, and the longer hind femur (more than $5.5 \times$ as long as the hind trochanter, about 4 times in *Hybrizon*) (mainly after Hisasue and Konishi 2019).

Material and methods

The collecting site is the Forestry Protection Station in Jinan (NE China, Shandong Prov., Shanghe County) and the collecting was done with Malaise traps. Images were acquired by using a KEYENCE VHX-5000 Digital Microscope imaging system and processed with Photoshop CC software.

For references to East Palaearctic genera and species of Hybrizontinae, see Yu et al. (2016) and for morphological terminology, see van Achterberg (1988). The specimens are deposited in the Institute of Insect Sciences, Zhejiang University, Hangzhou (**ZJUH**), Department of Life Sciences, Northwest University, Xi'an (**NWUX**) and Naturalis Biodiversity Center, Leiden (**RMNH**). An asterisk indicates new to the fauna.

DNA extraction

Genomic DNA was extracted from female adult specimens by using DNeasy Blood and Tissue Kit (Qiagen, Hilden, Germany) and following a non-destructive DNA extraction protocol as described in Taekul et al. (2014). Voucher specimens after extraction were washed by 100% alcohol and restored in Zhejiang University (Hangzhou, China).

PCR amplification and COI, 28SrRNA sequencing

The barcode region of the mitochondrial cytochrome oxidase subunit I (*COI*) was amplified using the LCO1490/HCO2198 primer pair: (F) (LCO1490) GGT-CAACAAATCATAA AGATATTGG; (R) (HCO2198) TAAACTTCAGGTGAC-CAAAAAATCA (Folmer et al. 1994). The nuclear 28S rRNA D1–2 (28S) was amplified using the primer part: (F) (3665) AGAGAGAGTTCAAGAGTACGTG; (R) (4068) TTGGTCCGTGTTTCAAGACGGG (Belshaw et al. 1998). PCRs were carried out using Tks Gflex DNA Polymerase (Takara) and conducted in a T100 Thermal Cycler (Bio-rad). PCR protocols followed the studied listed above for each molecule. Amplifications were sequenced by Sanger method on an Applied Biosystems (ABI) 3730XL by Sangon Biotech (Shanghai, China). All the amplified sequences were uploaded into GenBank (accession numbers in descriptions). The *COI* sequence of *H. buccatus* ([KU753286](#)) and 28S sequences of *H. buccatus* ([KU753494](#)) and *H. ghilarovi* ([EU378579](#)) were downloaded from GenBank. Sequences of *Lathrolestes nigricollis* (Thomson, 1883) ([GQ325436.1](#)) and *Perilissus rufoniger* (Gravenhorst, 1820) ([KR880228](#)) were used as out-groups to root the *COI* trees. Sequences of *Perilissus rufoniger* (Gravenhorst, 1820) ([EU378529](#)) was used as out-group to root the 28S rRNA tree.

Data analysis

The preliminary alignment was carried out by using MAFFT v.7.388 by the G-INS-I strategy for *COI* and Q-INS-I strategy for 28S (Katoh and Standley 2013). Alignments were checked and corrected manually, and the final alignments of *COI* and 28S were 635bp and 697bp, respectively. The alignments were then analyzed using RAxML as implemented in Geneious 11.0.3.

Results

The results of the RAxML analysis are presented in Figures 30, 31. The ML phylogenetic tree both of *COI* and 28S rRNA revealed that all species from Shandong province based on morphological characters were also supported by molecular differences. The

pairwise percentage identity of *COI* sequences between the three in-group species was 81.072% to 85.93%, with out-group *Lathrolestes nigricollis* and *Perilissus rufoniger*, was 76.717% to 78.559%, and 64.992% to 67.504%, respectively.

Genus *Hybrizon* Fallén, 1813

Figs 1–29

Hybrizon Fallén, 1813: 19; Bennett et al. 2019: 68; Hisasue and Konishi 2019: 241; for earlier references see van Achterberg et al. (2013) and Yu et al. (2016).

Syn.: *Paxylomma* de Brébisson, 1817; *Paxyloma* Stephens, 1835; *Paxylomme* Wesmael, 1835; *Paxyllomma* Curtis, 1837; *Paxylloma* Blanchard, 1840; *Pachylomma* Ratzeburg, 1848; *Plancus* Curtis, 1833; *Eupachylomma* Ashmead, 1894.

Key to East Palaearctic species of the genus *Hybrizon* Fallén

- 1 In lateral view length of hind basitarsus 4.0–5.0 times its maximum width (Figs 2, 3, 11); mesoscutum with pair of anteriorly broad bands of distinct punctures (Fig. 14), rarely punctures largely absent or obsolescent; vein 1-M of fore wing paler than vein 2-CU1 of fore wing (Fig. 10); basal cell of fore wing largely glabrous, with about 15 setae (Figs 1, 10), rarely more; scutellum (except sometimes laterally) dark brown as mesoscutum medio-posteriorly (Fig. 14); [length of fore wing 2–3 mm; propodeum largely smooth or granulate, except for medial carinae]; Mongolia, Russia, Japan (Kyushu, Shikoku), South Korea, China (Jilin; ?Heilongjiang; *Shaanxi; *Shandong).....
..... ***H. buccatus* (de Brébisson, 1825)**
- In lateral view length of hind basitarsus 5.4–7.0 times its maximum width (Figs 5, 18, 25); mesoscutum usually smooth, at most with narrow bands of punctures or notaulic area granulate (Figs 21, 28); vein 1-M of fore wing as dark as vein 2-CU1 of fore wing or nearly so (Figs 17, 24); basal cell of fore wing variable, **if** largely glabrous, then scutellum (except medio-anteriorly) ivory and contrasting with mesoscutum medio-posteriorly (Figs 26, 28)..... **2**
- 2 Basal cell of fore wing largely glabrous or sparsely setose, with 10–24 setae (Fig. 24); disco-submarginal cell of fore wing about as high as subdiscal cell (Fig. 24); ivory scutellum (except medio-anteriorly) distinctly contrasting with dark brown mesoscutum medio-posteriorly (Figs 26, 28), rarely both dark brown; anteriorly notaulic area of mesoscutum ivory or brownish (Figs 26, 28), rarely dark brown; scutellum strongly shiny and smooth (Fig. 28); maximum width of face 1.3–1.4 times its minimum width (Fig. 27); length of fore wing 2.6–3.7 mm; China (Shandong), South Korea ***H. xui* sp. nov.**
- Basal cell of fore wing (except basally) more or less evenly setose (Figs 4, 6, 17); disco-submarginal cell of fore wing 1.4–1.9 times as high as subdis-

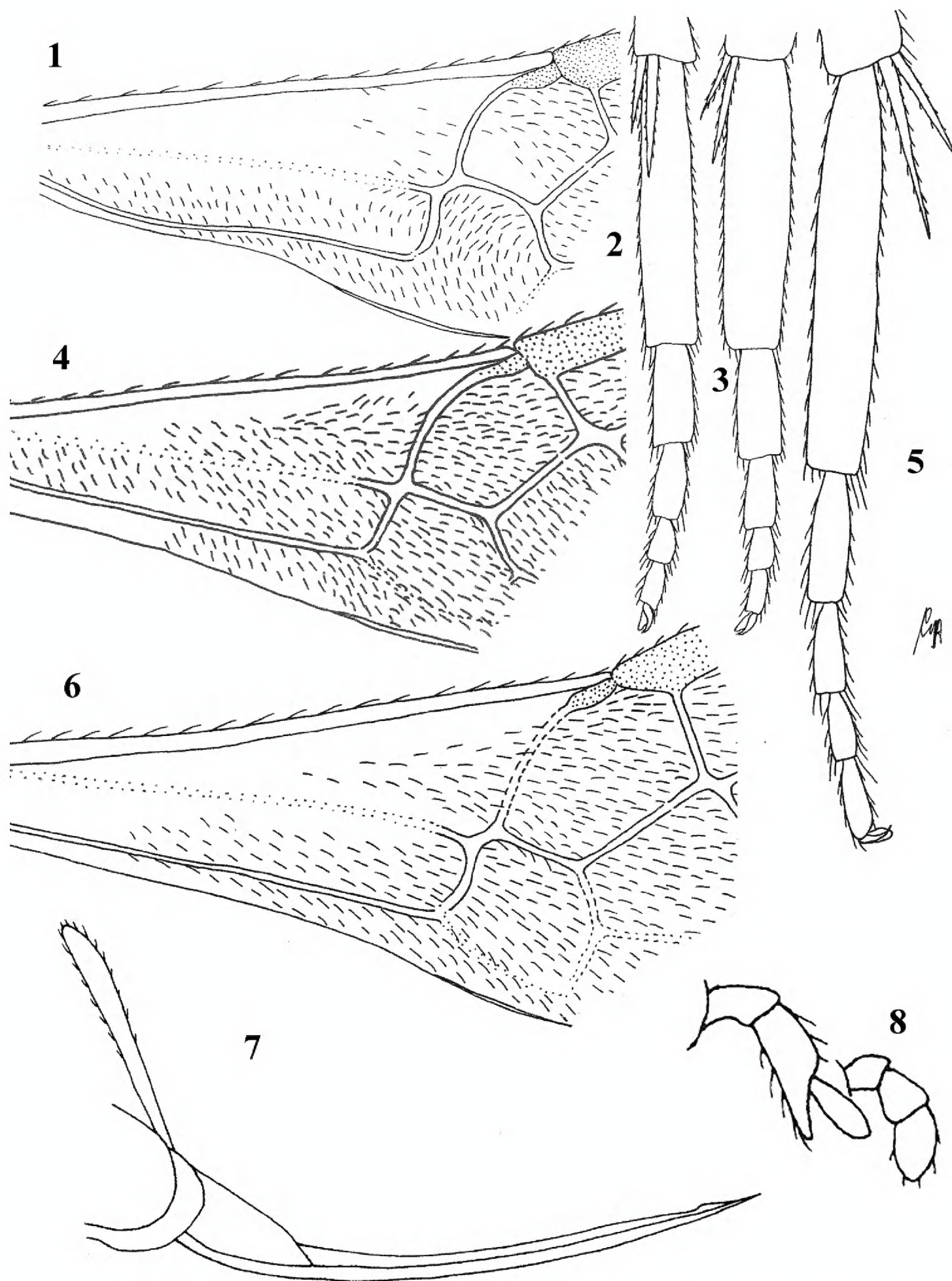
- cal cell (Figs 4, 6, 17); scutellum and mesoscutum medio-posteriorly usually similarly dark brown, but sometimes intermediate (Fig. 21); anteriorly notaulic area often dark brown; scutellum moderately shiny and more or less granulate (Fig. 21); maximum width of face 1.2–1.4 times its minimum width (Fig. 20); length of fore wing 2.1–3.1 mm.....**3**
- 3 Eyes distinctly setose; vein 1-M of fore wing straight anteriorly or nearly so (Fig. 6); ovipositor long and setose part of ovipositor sheath 0.5–0.7 times as long as second metasomal tergite (Fig. 7); scutellum and notaulic area of mesoscutum distinctly granulate; vein r of fore wing issued rather far from base of pterostigma (Fig. 6); pedicellus about as wide as scapus; [ventrally pedicellus yellowish or brown; ventral half of metapleuron coarsely rugose to densely rugulose]; Russia (Far East); Japan (Hokkaido), China (Hunan, Jilin, *Shaanxi), South Korea.....***H. ghilarovi* Tobias, 1988**
- Eyes glabrous (Fig. 21); vein 1-M of fore wing weakly curved anteriorly (Figs 4, 17), rarely nearly straight; ovipositor shorter and setose part of ovipositor sheath 0.2–0.4 times as long as second tergite (Figs 15, 16, 29); scutellum and mesoscutum smooth or superficially granulate (Fig. 21); vein r of fore wing issued close to base of pterostigma (Figs 4, 17); pedicellus slightly wider than scapus.....**4**
- 4 Face yellow; vein r of fore wing nearly vertical (Fig. 4); maximum width of face 1.1–1.2 times its minimum width; ventral half of face less shiny and more or less granulate; pedicellus brown ventrally, darker than yellowish scapus; Russia (Far East); China (Hunan) ***H. flavofacialis* Tobias, 1988**
- Face at least partly dark brown or brown (Fig. 20); vein r of fore wing distinctly oblique (Fig. 17); maximum width of face 1.3–1.4 times its minimum width (Fig. 20); ventral half of face distinctly shiny and largely smooth; pedicellus and scapus ventrally similarly yellowish or pedicellus somewhat darker (Figs 16, 19, 21); [ventral half of metapleuron and of mesopleuron granulate]; China (Shandong).....***H. hei* sp. nov.**

Species occurring in China

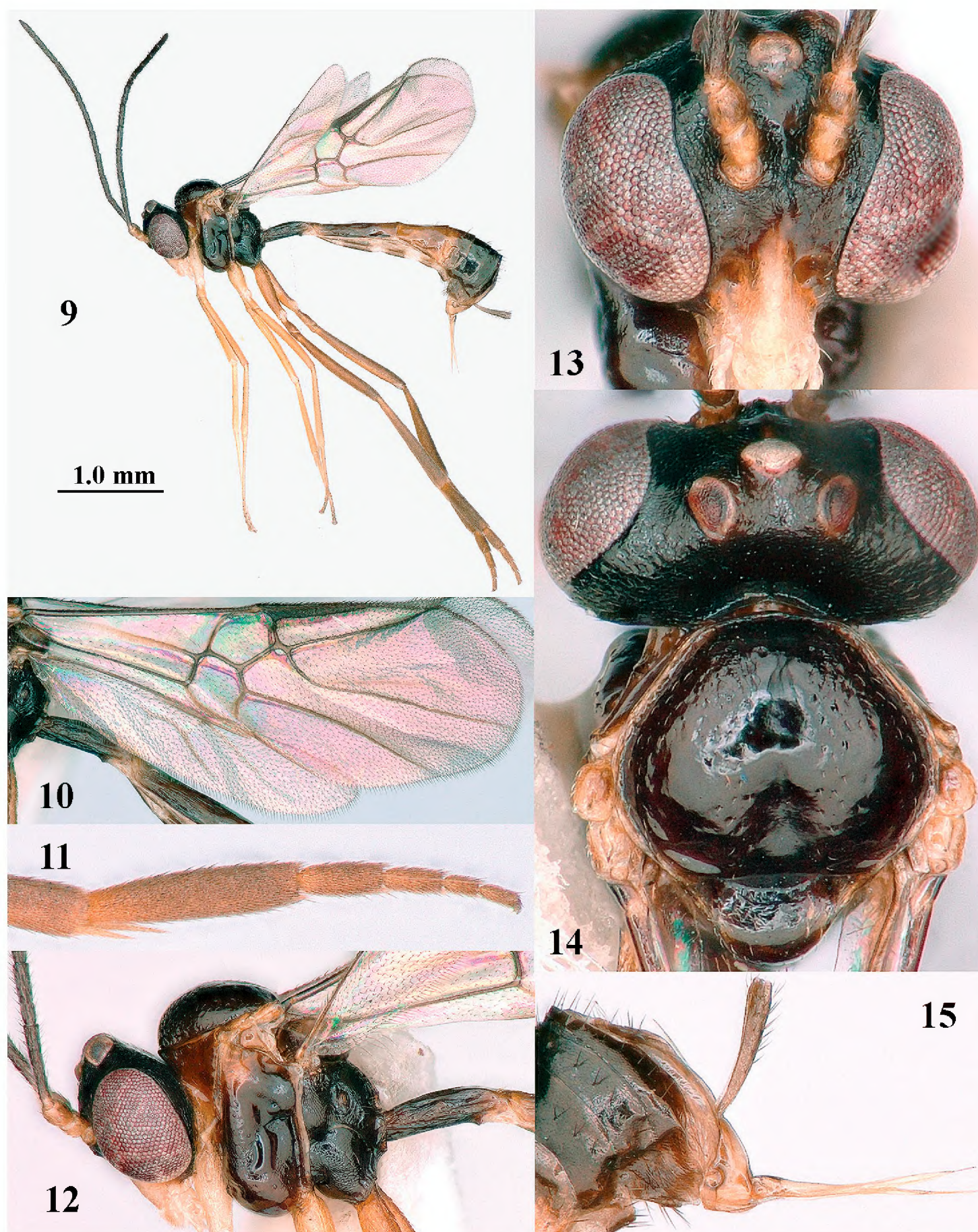
Hybrizon buccatus (de Brébisson, 1825)

Figs 1–3, 9–15

Material. 1 ♀ (ZJUH), “NE China: Shandong, Shanghe County, Ji’nan, Xushang, Dong Balizhuang, 36°16'4"N, 117°9'10"E, Malaise trap, 24–30.ix.2018, Jia-He Yan & Qi-Meng Yang”; 2 ♀ (NWUX), “NW China: Shaanxi, Xunyangba, Ningshaan, 1481 m, Y[ellow] & G[reen] [Malaise] trap, 33°54'N, 108°55'E, 1.vii–17.viii.2016, Tan JL & Tan QQ, NWUX”. Reported from North China by He (1981: Heilongjiang, Jilin) and by Konishi et al. (2012: Jilin). The figured specimen in He (1981) probably belongs to *H. xui* sp. nov. The listed material could not be retrieved, but



Figures 1–8. 1–3 *Hybrizon buccatus* (de Brébisson) ♀, Bulgaria, Brodilovo, but 3 of ♀ from Netherlands, Nunspeet 4, 5 *H. flavofacialis* Tobias, female, China, Hunan, Yuanjiang 6, 7 *H. ghilarovi* Tobias: 6 of ♀, China, Hunan, Yuanjiang and 7 of ♀, Bulgaria, Brodilovo 8 *H. juncoi* (Ceballos), ♀, Spain, Estepona 1, 4, 6 basal half of fore wing 2, 3, 5 hind basitarsus lateral 7 ovipositor and sheath lateral 8 palpi anterior. From van Achterberg (1999) and van Achterberg et al. (2013).



Figures 9–15. *Hybrizon buccatus* (de Brébisson), ♀, China, Shandong **9** habitus, lateral aspect **10** wings **11** hind tarsus, lateral aspect **12** head and mesosoma, lateral aspect **13** head, anterior aspect **14** head and mesosoma, dorsal aspect **15** ovipositor and ovipositor sheath, lateral aspect.

the figure shows a slender hind basitarsus (about 6 times as long as wide) and vein r of fore wing connected somewhat distally from base of pterostigma, what does not fit with *H. buccatus*.

Differentiating diagnosis. Easily to separate from other Chinese species because of the largely glabrous basal cell of fore wing, combined with dark brown scutellum, less slender hind basitarsus and lesser body size (length of fore wing not exceeding 3 mm).

***Hybrizon flavofacialis* Tobias, 1988**

Figs 4, 5

Material. Series from S. China (Hunan) listed by van Achterberg et al. (2013).

Differentiating diagnosis. Differs from other Chinese species by the long and robust ovipositor, the granulate mesoscutum and scutellum, and the nearly vertical vein r of fore wing.

***Hybrizon ghilarovi* Tobias, 1988**

Figs 6, 7

Material. 1 ♀ (NWUX), “NW China: Shaanxi, Panda valley, Foping, black Mal[aise] trap, 1411 m, 33°67'N, 107°97'E, 29.v.–19.vi.2016, Tan JL & C. v. A[chterberg], NWUX”. Series from S. China (Hunan) listed by van Achterberg et al. (2013). Koni-shi et al. (2012) reported this species from NE China (Jilin).

Differentiating diagnosis. Differs from other Chinese species by the distinctly setose eyes, vein 1-M of fore wing straight anteriorly or nearly so (Fig. 8) and long setose part of ovipositor sheath (0.6–0.7 times as long as second metasomal tergite).

***Hybrizon hei* van Achterberg & Liu, sp. nov.**

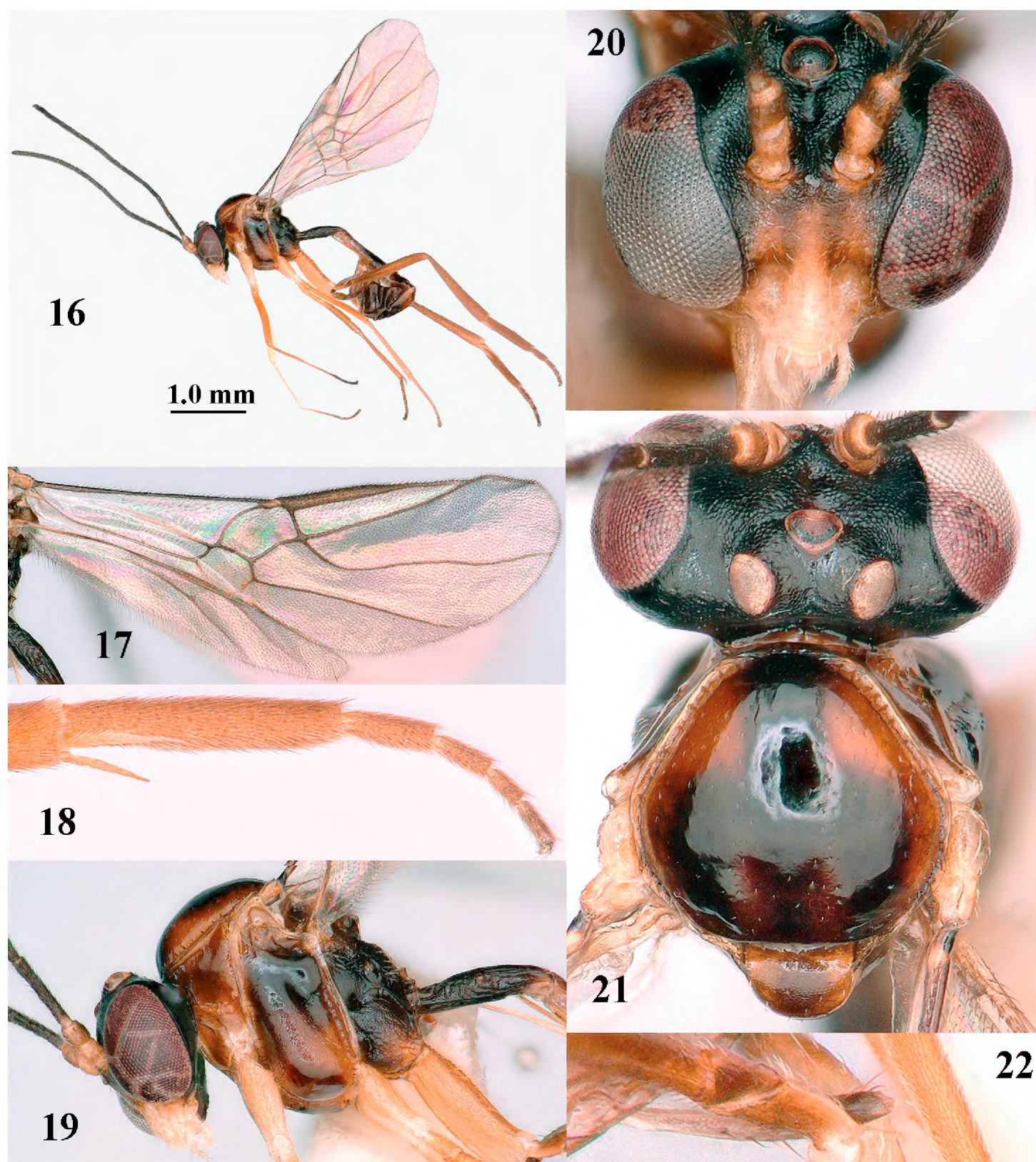
<http://zoobank.org/AF9727B5-5B3F-471F-9026-539BBFC0B781>

Figs 16–22

Type material. Holotype, ♀ (ZJUH), “NE China: Shandong, Shanghe County, Ji’nan, Xushang, Dong Balizhuang, 36°16'4"N, 117°9'10"E, Malaise trap, 24–30.ix.2018, Jia-He Yan & Qi-Meng Yang”, “20190119” (the molecular sequences originate from this specimen). Paratypes (ZJUH, RMNH): 10 ♀, same data as holotype.

Differentiating diagnosis. The West Palaearctic *H. pilialatus* Tobias, 1988, is very similar to the new species, but *H. pilialatus* has vein r of fore wing distinctly removed from base of pterostigma and less oblique (Fig. 15 in van Achterberg 1999; vein r issued virtually at base of pterostigma and distinctly oblique in *H. hei*), disco-submarginal cell of fore wing 1.1 times higher than subdiscal cell (1.5–1.9 times in *H. hei*) and vein 1-R1 (= metacarp) of fore wing about 0.4 times length of pterostigma (about 0.6 times in *H. hei*). According to the molecular analyses it is distinctly separated from *H. xui* and *H. buccatus* (Figs 30, 31); unfortunately, molecular data of its most closely relative (*H. pilialatus*) are yet unknown.

Molecular data. [MN168094](#) (28S) and [MN125615](#) (COI).



Figures 16–22. *Hybrizon hei* sp. nov., ♀, paratype **16** habitus, lateral aspect **17** wings **18** hind tarsus, lateral aspect **19** head and mesosoma, lateral aspect **20** head, anterior aspect **21** head and mesosoma, dorsal aspect **22** ovipositor and ovipositor sheath, lateral aspect.

Description. Holotype, ♀, length of body 3.6 mm, of fore wing 2.6 mm.

Head. Antenna with 13 segments and 0.9 times as long as fore wing, length of third segment 1.3 times fourth segment, length of third, fourth and penultimate segments 6.5, 5.0 and 3.0 times their width, respectively; pedicellus slightly longer and wider than scapus; apical segment of maxillary palp rather elongate (compared to width of penultimate segment; Fig. 19); face rugulose-granulate medio-dorsally and remainder largely smooth (Fig. 20); maximum width of face 1.4 times its minimum width (Fig. 20); frons granulate and rather shiny, near antennal sockets depressed and

rugulose; length of eye 3.8 times temple in dorsal view; temples directly narrowed behind eyes; vertex shiny and very superficially granulate; OOL:diameter of ocellus:POL = 3:3:6; length of malar space 2.5 times basal width of mandible, concave, anteriorly smooth and posteriorly granulate.

Mesosoma. Length of mesosoma 1.1 times its height; mesoscutum strongly shiny, smooth (except for some superficial punctulation) and without notauli (Fig. 21); scutellum convex and moderately shiny, superficially granulate (Fig. 21); ventral half of mesopleuron rather matt and granulate; mesosternal sulcus narrow and smooth; metapleuron shiny and granulate; metanotum slightly and obtusely protruding dorsally; propodeum granulate, but medially and posteriorly areolate with interspaces largely smooth.

Wings. Fore wing: marginal cell comparatively slender (Fig. 17); basal cell of fore wing largely and evenly setose (Fig. 17); vein r issued at base of pterostigma and distinctly oblique (Fig. 17); vein 1-M moderately curved and medium-sized, with disco-submarginal cell 1.5 times higher than subdiscal cell.

Legs. Hind coxa granulate; in lateral view length of femur, tibia and basitarsus of hind leg 8.3, 7.6 and 5.6 times their width, respectively; spurs of hind tibia 0.3 and 0.4 times hind basitarsus.

Metasoma. Length of first tergite 3.1 times its apical width, shiny, smooth except some aciculae, laterally rugose (Fig. 19), subapically parallel-sided and its spiracles slightly protruding; basal half of second tergite with some weak striae; remainder of metasoma smooth and shiny; hypopygium with bristly setae; second tergite with sharp lateral crease; length of setose part of ovipositor sheath 0.08 times fore wing and 0.26 times second metasomal tergite (Fig. 22); ovipositor needle-shaped.

Colour. Dark brown or brownish black; mouthparts (including mandible) and clypeus largely white; scapus, pedicellus ventrally, tegulae, legs and anterior half of fourth tergite yellowish brown; scutellum (except medially), pronotum, mesosternum, mesopleuron (except dorsally) and metasoma (except first tergite) mainly brown; remainder of antenna largely dark brown; veins and pterostigma largely brown; vein 1-M of fore wing paler than vein 2-CU1 of fore wing; wing membrane subhyaline.

Variation. Length of body (2.3–)3.4–4.1 mm, of fore wing (2.1–)2.6–2.9 mm; maximum width of face 1.3–1.4 times its minimum width; in lateral view length of hind basitarsus 5.4–5.8(–6.3) times its maximum width; disco-submarginal cell of fore wing 1.4–1.7(–1.9) times higher than subdiscal cell; scutellum sometimes rather flat and not reaching level of mesoscutum, but in most specimens convex and protruding above level of mesoscutum, dark brown to largely pale yellowish; face dark brown or partly pale brown, frequently with ivory stripe medially; mesoscutum dark brown or brown antero-laterally.

Distribution. China (Shandong).

Etymology. Named after Prof. Dr Jun-Hua He (Zhejiang University, Hangzhou) on the occasion of his 90th birthday for his numerous contributions to the systematics of Chinese Hymenoptera for more than 45 years.

***Hybrizon xui* van Achterberg & Liu, sp. nov.**

<http://zoobank.org/4AA0A64B-BA65-43EA-9249-7A9EF3EE05AA>

Figs 23–29

Hybrizon juncoi: Konishi et al. 2012: 21, 22.

Type material. Holotype, ♀ (ZJUH), “NE China: Shandong, Shanghe County, Ji’nan, Xushang, Dong Balizhuang, 36°16'4"N, 117°9'10"E, Malaise trap, 24–30.ix.2018, Jia-He Yan & Qi-Meng Yang”, Paratypes (ZJUH, RMNH): 40 ♀, same data as holotype, of which 1 ♀ (ZJUH) additionally labelled “201901120”, because the molecular sequences originate from this specimen.

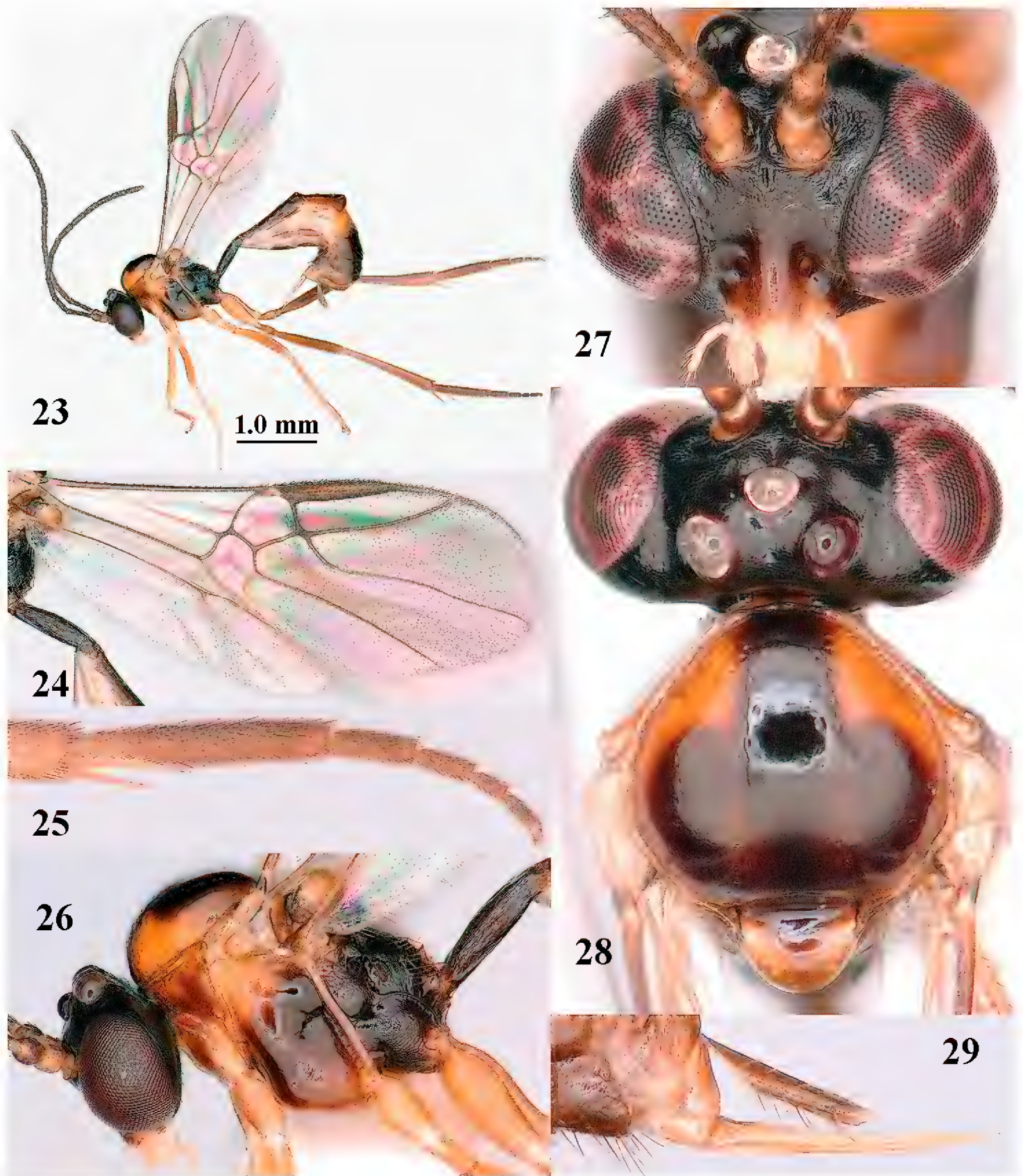
Differentiating diagnosis. The new species is similar to the SW Palaearctic *H. juncoi* (Ceballos, 1957), because of the largely glabrous basal cell of the fore wing, vein 1-M of fore wing as dark as vein 2-CU1 of fore wing, ivory scutellum (except medio-anteriorly), larger body size and anterior notaulic area of mesoscutum more or less ivory or brownish. Konishi et al. (2012) included Korean specimens of this species under *H. juncoi*, but *H. juncoi* has the hind basitarsus about 4.5 times longer than wide (both sexes; 5.6–6.8 times in *H. xui*), vein r of fore wing issued comparatively far removed from base of pterostigma (distance to base of pterostigma about equal to length of vein r; much less so in *H. xui*), propodeum distinctly rugose-granulate (granulate and partly smooth in *H. xui*), vein 1-M comparatively short (fig. 41 in van Achterberg 1999), resulting in a transverse disco-submarginal cell lower than subdiscal cell (vein 1-M medium-sized, resulting in a disco-submarginal cell as high as subdiscal cell in *H. xui*) and penultimate segment of maxillary palp enlarged (Fig. 8; small in *H. xui*). According to the molecular analyses it is distinctly separated from *H. hei* and *H. buccatus* (Figs 30, 31); unfortunately, molecular data of its most closely relative (*H. juncoi*) are yet unknown.

Molecular data. [MN168195](#) (28S) and [MN260327](#) (COI).

Description. Holotype, ♀, length of body 4.2 mm, of fore wing 3.1 mm.

Head. Antenna with 13 segments and 0.9 times as long as fore wing, length of third segment 1.4 times fourth segment, length of third, fourth and penultimate segments 5.3, 3.8 and 3.3 times their width, respectively; pedicellus slightly shorter than and as wide as scapus; penultimate segment of maxillary palp small compared to apical segment (Fig. 26); face rugulose-granulate medio-dorsally and remainder largely smooth; maximum width of face 1.4 times its minimum width (Fig. 27); frons smooth and shiny but near antennal sockets depressed and rugulose; length of eye 6.8 times temple in dorsal view; temples directly narrowed behind eyes; vertex shiny and superficially granulate; OOL:diameter of ocellus:POL = 3:5:7; length of malar space 1.3 times basal width of mandible, concave and largely smooth, posteriorly granulate.

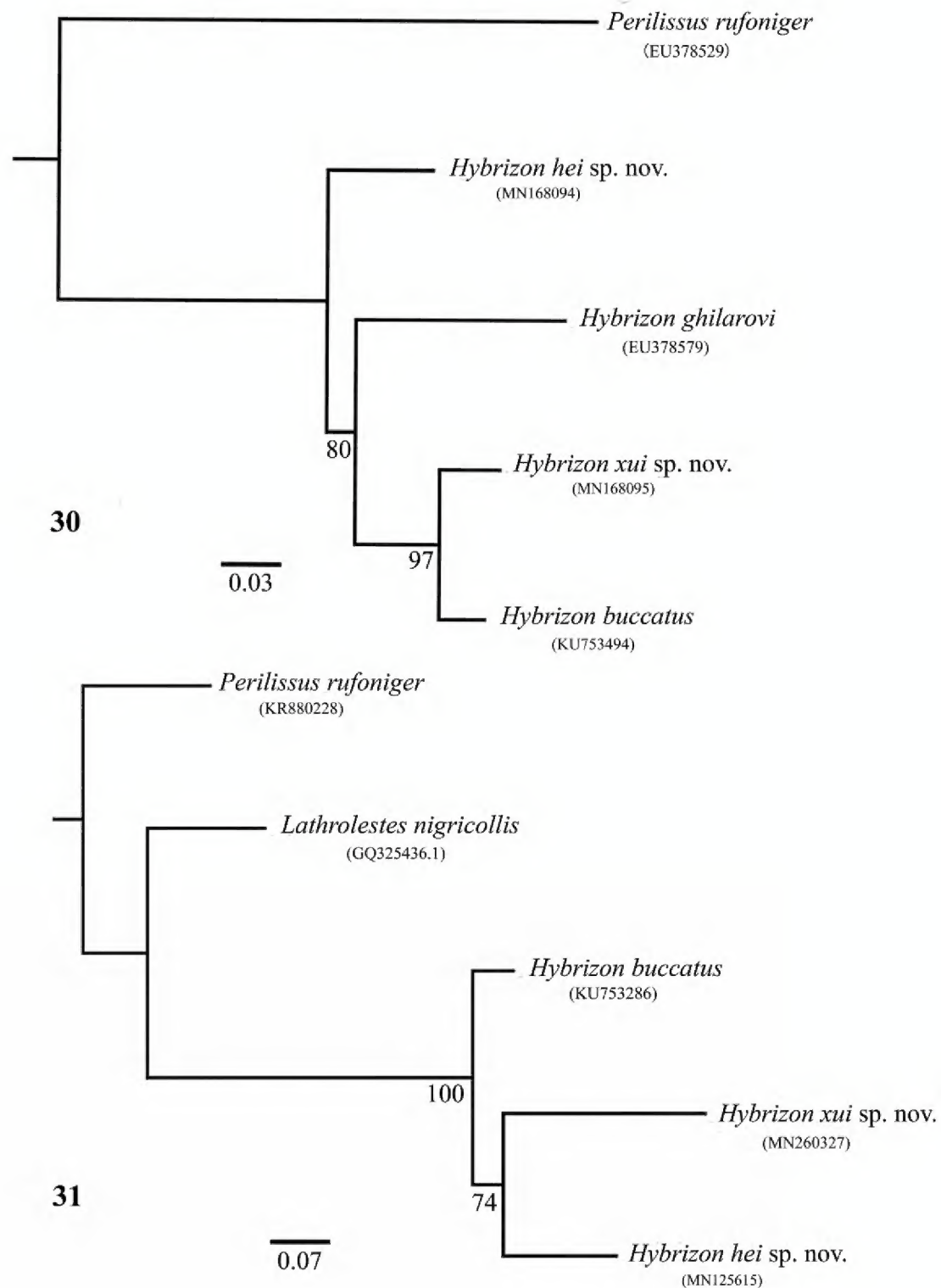
Mesosoma. Length of mesosoma 1.2 times its height; mesoscutum strongly shiny and smooth, only anteriorly with few punctures and notauli absent (Fig. 28); scutellum strongly convex (protruding up to dorsal level of mesoscutum or above) and shiny, smooth (Figs 26, 28); mesopleuron shiny and largely smooth; mesosternal sulcus nar-



Figures 23–29. *Hybrizon xui* sp. nov., ♀, paratype **23** habitus, lateral aspect **24** wings **25** hind tarsus, lateral aspect **26** head and mesosoma lateral aspect **27** head, anterior aspect **28** head and mesosoma, dorsal aspect **29** ovipositor and ovipositor sheath, lateral aspect.

row and smooth; metapleuron shiny and granulate; metanotum obtusely protruding dorsally; propodeum granulate, but medially and posteriorly with some rugae or carinae and interspaces largely smooth.

Wings. Fore wing: marginal cell comparatively wide (Fig. 24); basal cell of fore wing largely glabrous, with 18 setae (Fig. 24); vein r nearly vertical and issued comparatively close to base of pterostigma (Fig. 24); vein 1-R1 0.6 times length of pterostig-



Figures 30, 31. RAxML result analysis of 28S and COI sequences. Numbers in parentheses are GenBank numbers.

ma; vein 1-M moderately curved and medium-sized, resulting in a disco-submarginal cell as high as subdiscal cell.

Legs. Hind coxa finely granulate; in lateral view length of femur, tibia and basitarsus of hind leg 6.9, 6.8 and 5.6 times their width, respectively; spurs of hind tibia 0.35 and 0.40 times hind basitarsus.

Metasoma. Length of first tergite 3.4 times its apical width, shiny, smooth (also laterally), medially with shallow elongate depression, subapically widened and its spiracles slightly protruding; second tergite with spaced striae basally and some superficial micro-sculpture medially; remainder of metasoma smooth and shiny; hypopygium

with long bristly setae (Fig. 29); second tergite with sharp lateral crease; length of setose part of ovipositor sheath 0.08 times fore wing and 0.26 times second metasomal tergite.

Colour. Dark brown; mouthparts (including mandible) and tegulae white; scapus, and scutellum (except medio-anteriorly) ivory; scutellum distinctly contrasting with dark brown mesoscutum medio-posteriorly (Fig. 28); mesoscutum antero-laterally, pronotum, mesosternum, mesopleuron dorsally and ventrally, anterior half of fourth tergite and legs yellowish brown; pedicellus entirely brown and distinctly contrasting with pale scapus (Figs 26, 27), remainder of antenna largely dark brown; veins and pterostigma largely dark brown; vein 1-M of fore wing as dark as vein 2-CU1 of fore wing or nearly so; wing membrane subhyaline.

Variation. Length of body (3.2–)3.6–4.5 mm, of fore wing 2.6–3.7 mm; maximum width of face 1.3–1.4 times its minimum width; basal cell of fore wing with 10–24 setae; anteriorly notaulic area of mesoscutum ivory or brownish yellow, rarely dark brown; in lateral view length of hind basitarsus 5.4–6.6 times its maximum width; pedicellus entirely brown or dark brown, rarely pale yellowish ventrally; apical half of fourth tergite dark brown to brownish yellow; hind leg brownish yellow to brown. One paratype has a transverse groove subbasally on the second tergite.

Distribution. China (Shandong).

Etymology. Named in commemoration of the much too early deceased hymenopterist Prof. Dr Zai-Fu Xu (South China Agricultural University, Guangzhou; ix.1965 – vi.2017) for his great contributions to our knowledge of the Chinese Hymenoptera.

Discussion

There are five species (including the two new species in present study) recognized from the Chinese fauna (van Achterberg et al. 2013, Konishi et al. 2012). The three species of *Hybrizon* from Shandong province are separated by the morphological characters and supported by the genetic distance between *COI* sequences as well. Unfortunately, molecular data of most closely relative species (*H. pilialatus* Tobias, 1988 and *H. juncoi* (Ceballos, 1957) are not yet known. But all these species can be distinguished based on the morphological characters alone. Konishi et al. (2012) included the Korean specimens under *H. juncoi* (Ceballos, 1957), but based on the ratio of length to width of hind basitarsus, we consider it should be a misidentification and include it under *H. xui* sp. nov. Based on the pairwise percentage identity of *COI* sequences of the three species from China are also significantly different, the genetic distance between species from the same locality is also very high.

The specimens of *Hybrizon hei* sp. n and *H. xui* sp. nov. collected in the Malaise trap in Shandong province all are female, there are 11 individuals of *H. hei* sp. nov. and 41 individuals of *H. xui* sp. nov. Only a single female specimen of *H. buccatus* was found in the same locality. Biologically, species of Hybrizontinae are known to be associated with ants (Donisthorpe and Wilkinson 1930, Gómez Durán and van Achterberg 2011, Hisasue and Konishi 2019), it is highly likely that the new species from Shandong also emerged from some ant nest near the Malaise trap.

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